FIG. 1

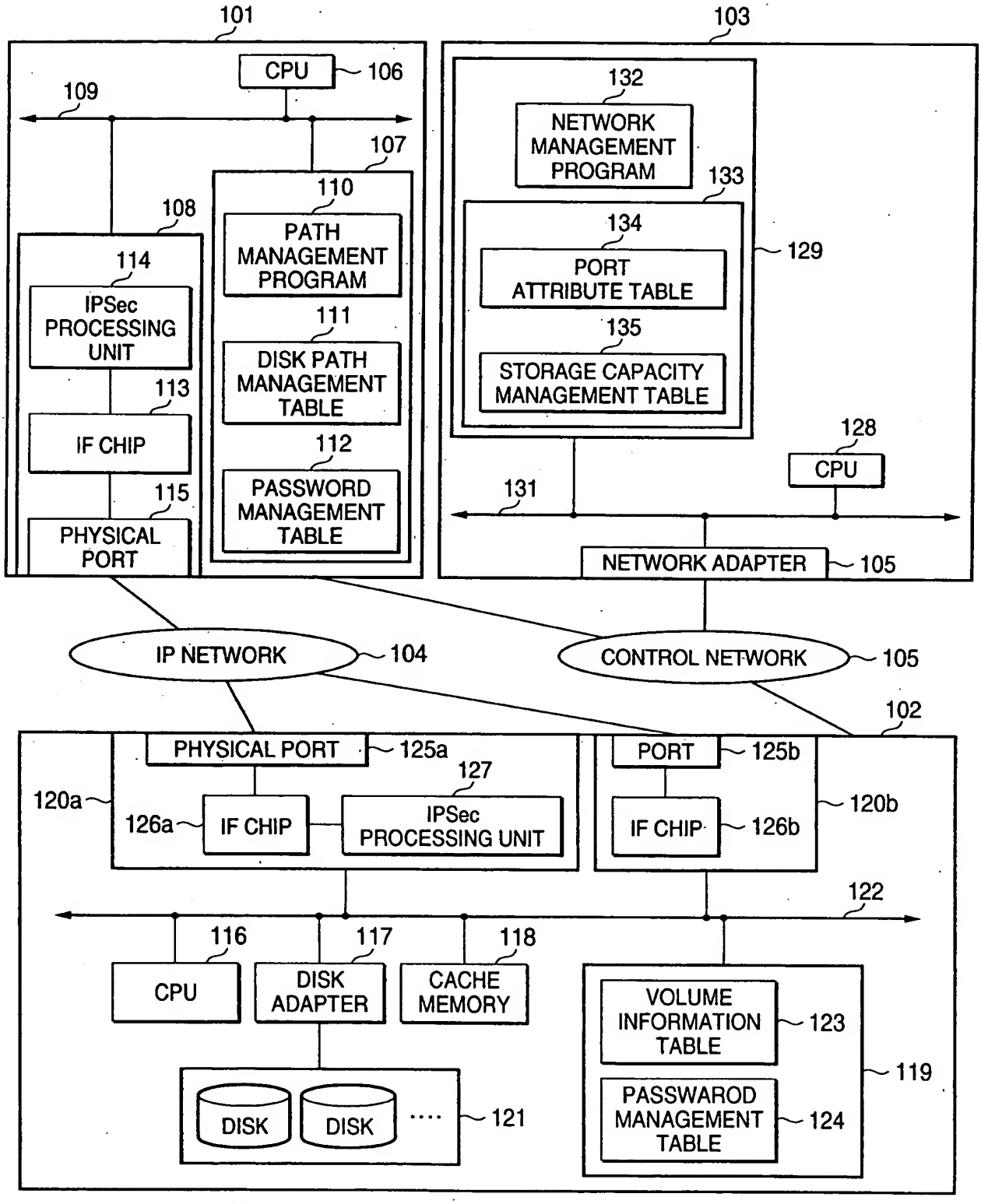

101
CPU
106
109
107
110
PATH MANAGEMENT PROGRAM
111
DISK PATH MANAGEMENT TABLE
112
PASSWORD MANAGEMENT TABLE
108
114
IPSec PROCESSING UNIT
113
IF CHIP
115
PHYSICAL PORT
103
132
NETWORK MANAGEMENT PROGRAM
133
134
PORT ATTRIBUTE TABLE
135
STORAGE CAPACITY MANAGEMENT TABLE
129
128
CPU
131
NETWORK ADAPTER
105
IP NETWORK
104
CONTROL NETWORK
105
102
PHYSICAL PORT
125a
127
120a
126a
IF CHIP
IPSec PROCESSING UNIT
PORT
125b
IF CHIP
126b
120b
122
116
117
118
CPU
DISK ADAPTER
CACHE MEMORY
VOLUME INFORMATION TABLE
123
119
PASSWAROD MANAGEMENT TABLE
124
DISK
DISK
....
121

FIG. 2

201 NODE IDENTIFIER	202 OBJECT IDENTIFIER	203 IP ADDRESS	204 NODE TYPE	205 PROVIDED WITH IPSec?	206 AUTHENTICATION IDENTIFIER	207 PASSWORD
Host1	iqn.2003-01.com.example: host1	10.10.10.101	HOST	YES	10.10.10.101	aaaaaa
Host2	iqn.2003-02.com.example: host2	10.10.10.102	HOST	NO	-	-
Host3	iqn.2003-03.com.example: host3	10.10.10.103	HOST	YES	10.10.10.103	cccccc
Storage1	iqn.2003-03.com.example: storage1	10.10.10.201	STORAGE	YES	10.10.10.201	dddddd
	iqn.2003-04.com.example: storage1	10.10.10.202	STORAGE	NO	-	-
Storage2	iqn.2003-05.com.example: storage2	10.10.10.203	STORAGE	YES	10.10.10..203	ffffff
	-	10.10.10.204	STORAGE	NO	-	-
Storage3	iqn.2003-06.com.example: storage3	10.10.10.205	STORAGE	YES	10.10.10.205	hhhhhh

FIG. 3

301 NODE IDENTIFIER	302 UNUSED CAPACITY	303 USED CAPACITY
STORAGE 1	10TB	5TB
STORAGE 2	20TB	12TB
STORAGE 3	8TB	2TB

FIG. 4

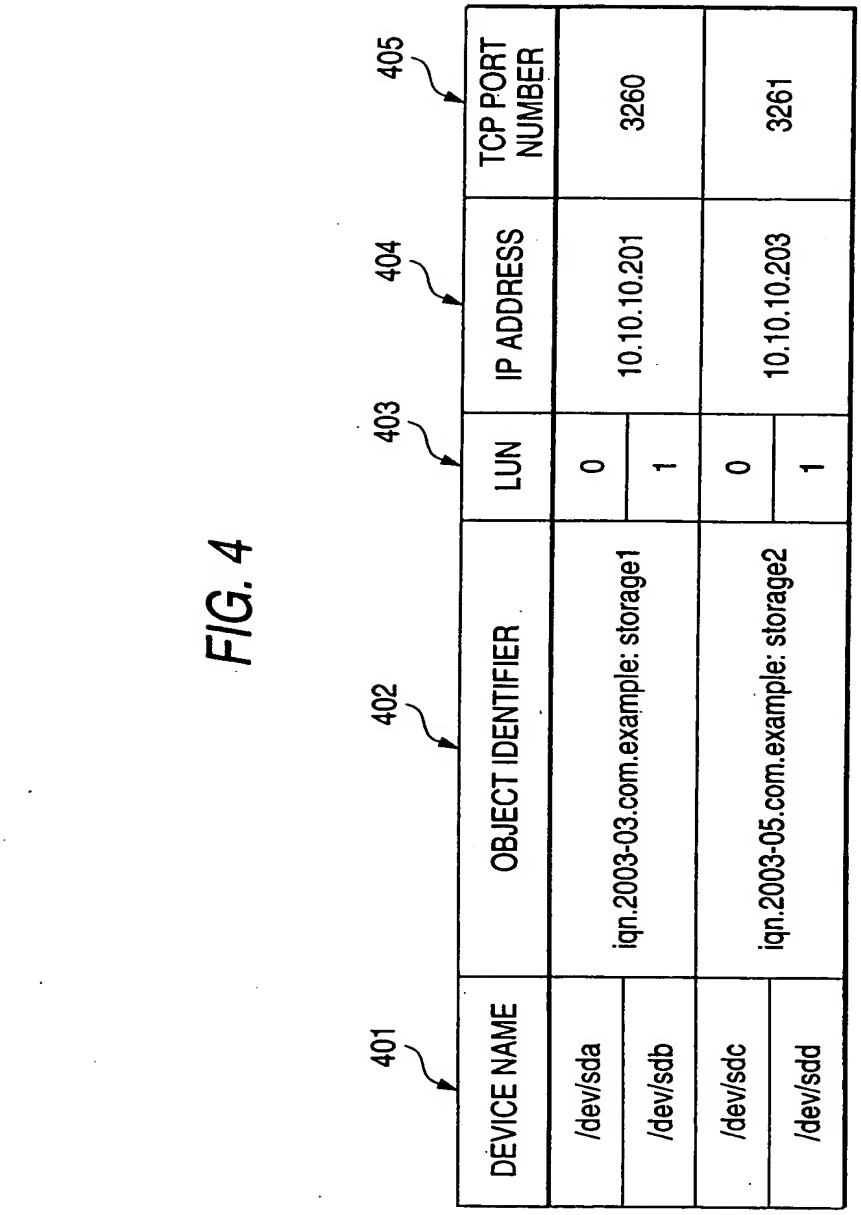

401
402
403
404
405
DEVICE NAME
OBJECT IDENTIFIER
LUN
IP ADDRESS
TCP PORT NUMBER
/dev/sda
iqn.2003-03.com.example: storage1
0
10.10.10.201
3260
/dev/sdb
1
/dev/sdc
iqn.2003-05.com.example: storage2
0
10.10.10.203
3261
/dev/sdd
1

FIG. 5

501 PHYSICAL VOLUME NUMBER	502 LUN	503 CAPACITY	504 IP ADDRESS OF ASSIGNED PHYSICAL PORT	505 TCP PORT NUMBER	506 OBJECT IDENTIFIER OF ASSIGNED PHYSICAL PORT	508 PROVIDED WITH IPSec?
VOL. 0	0	200GB	10.10.10.201	3260	iqn.2003-01.com.example: storage1	YES
VOL. 1	1	400GB				
VOL. 2	2	350GB	10.10.10.202	3261	iqn.2003-04.com.example: storage1	NO
VOL. 3	3	600GB				

FIG. 6

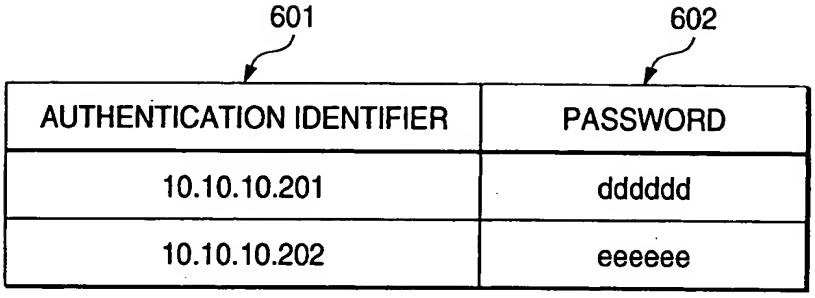

601
602
AUTHENTICATION IDENTIFIER
PASSWORD
10.10.10.201
dddddd
10.10.10.202
eeeeee

FIG. 7

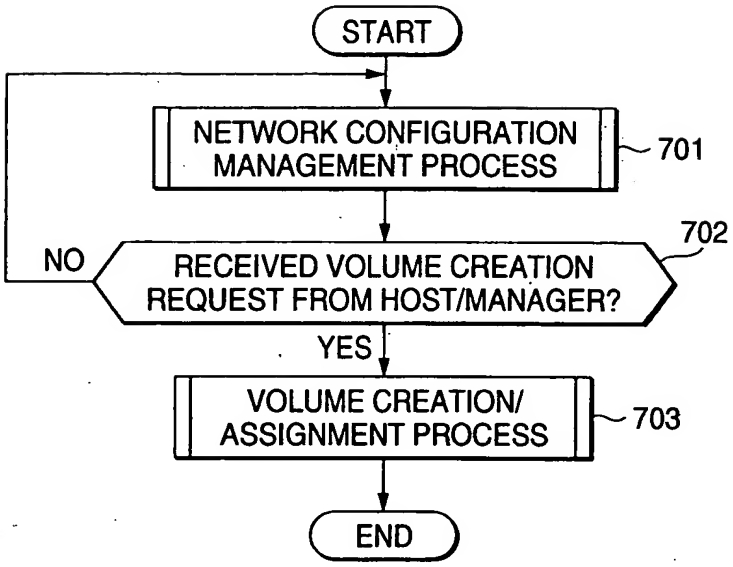

START
NETWORK CONFIGURATION MANAGEMENT PROCESS
701
RECEIVED VOLUME CREATION REQUEST FROM HOST/MANAGER?
702
NO
YES
VOLUME CREATION/ ASSIGNMENT PROCESS
703
END

FIG. 8

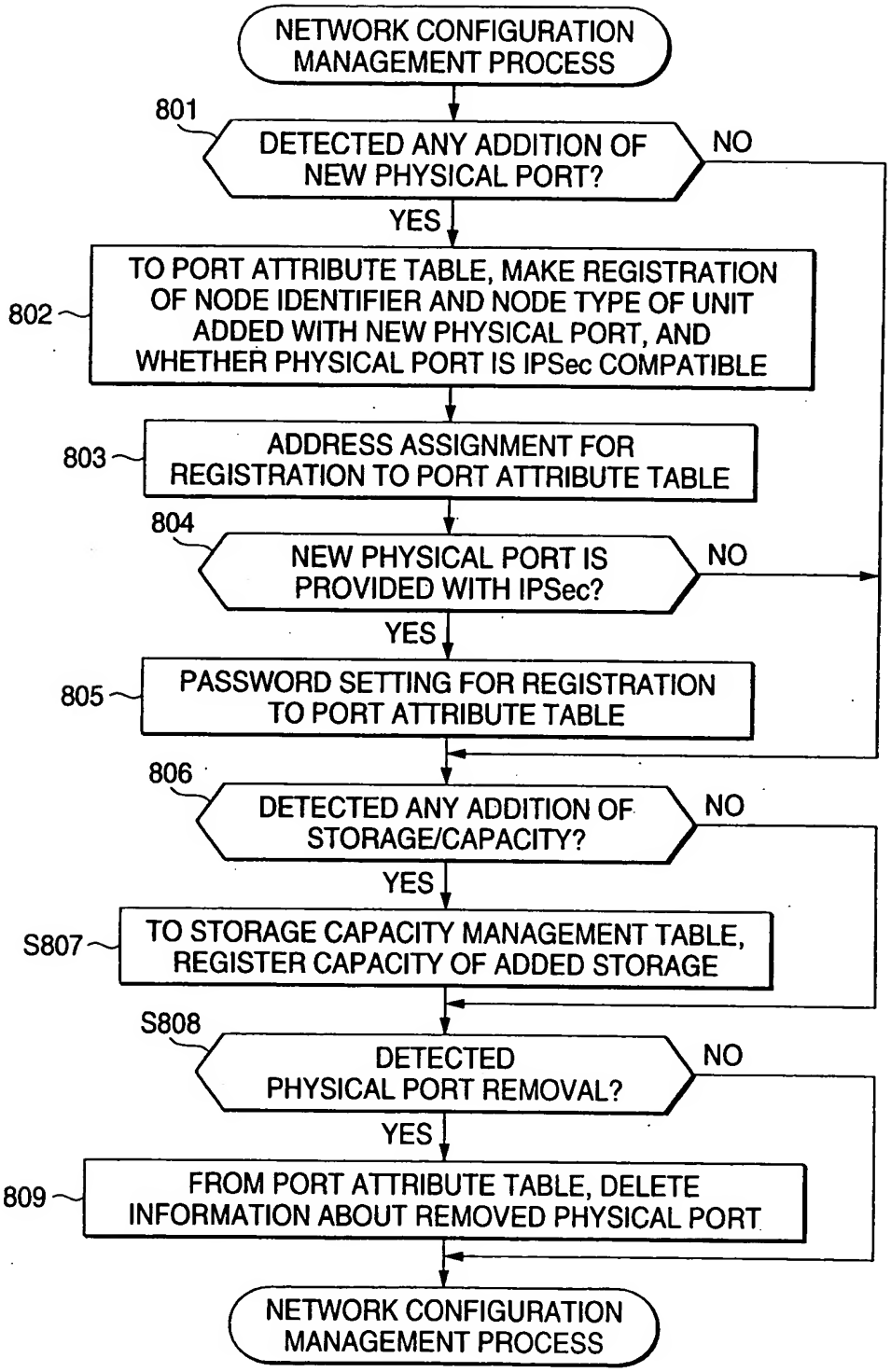

NETWORK CONFIGURATION MANAGEMENT PROCESS
801
DETECTED ANY ADDITION OF NEW PHYSICAL PORT?
NO
YES
802
TO PORT ATTRIBUTE TABLE, MAKE REGISTRATION OF NODE IDENTIFIER AND NODE TYPE OF UNIT ADDED WITH NEW PHYSICAL PORT, AND WHETHER PHYSICAL PORT IS IPSec COMPATIBLE
803
ADDRESS ASSIGNMENT FOR REGISTRATION TO PORT ATTRIBUTE TABLE
804
NEW PHYSICAL PORT IS PROVIDED WITH IPSec?
NO
YES
805
PASSWORD SETTING FOR REGISTRATION TO PORT ATTRIBUTE TABLE
806
DETECTED ANY ADDITION OF STORAGE/CAPACITY?
NO
YES
S807
TO STORAGE CAPACITY MANAGEMENT TABLE, REGISTER CAPACITY OF ADDED STORAGE
S808
DETECTED PHYSICAL PORT REMOVAL?
NO
YES
809
FROM PORT ATTRIBUTE TABLE, DELETE INFORMATION ABOUT REMOVED PHYSICAL PORT
NETWORK CONFIGURATION MANAGEMENT PROCESS

FIG. 9

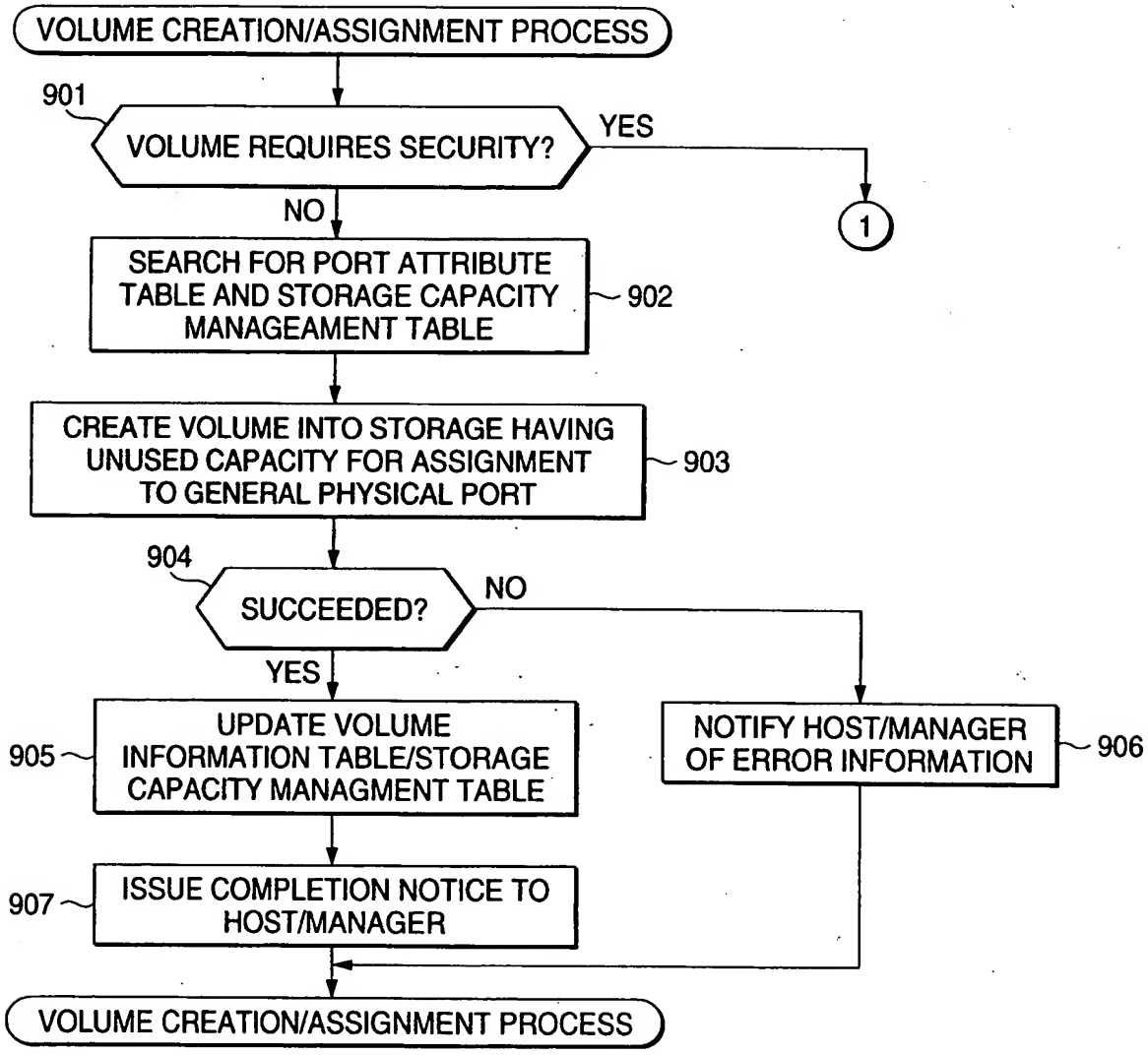

VOLUME CREATION/ASSIGNMENT PROCESS
901
VOLUME REQUIRES SECURITY?
YES
1
NO
SEARCH FOR PORT ATTRIBUTE TABLE AND STORAGE CAPACITY MANAGEAMENT TABLE
902
CREATE VOLUME INTO STORAGE HAVING UNUSED CAPACITY FOR ASSIGNMENT TO GENERAL PHYSICAL PORT
903
904
SUCCEEDED?
NO
YES
905
UPDATE VOLUME INFORMATION TABLE/STORAGE CAPACITY MANAGMENT TABLE
NOTIFY HOST/MANAGER OF ERROR INFORMATION
906
907
ISSUE COMPLETION NOTICE TO HOST/MANAGER
VOLUME CREATION/ASSIGNMENT PROCESS

FIG. 10

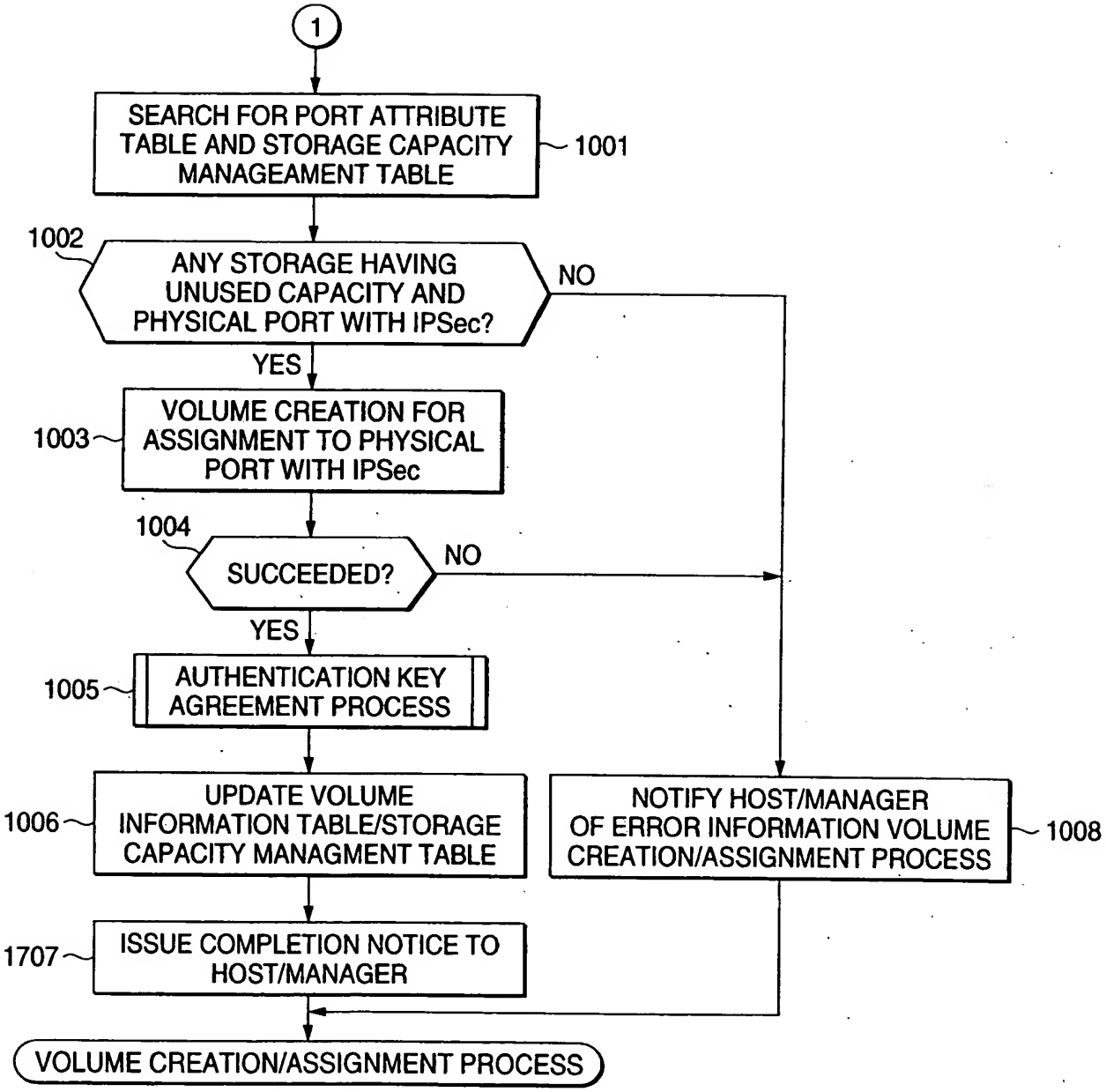

1
SEARCH FOR PORT ATTRIBUTE TABLE AND STORAGE CAPACITY MANAGEAMENT TABLE
1001
1002
ANY STORAGE HAVING UNUSED CAPACITY AND PHYSICAL PORT WITH IPSec?
NO
YES
1003
VOLUME CREATION FOR ASSIGNMENT TO PHYSICAL PORT WITH IPSec
1004
SUCCEEDED?
NO
YES
1005
AUTHENTICATION KEY AGREEMENT PROCESS
1006
UPDATE VOLUME INFORMATION TABLE/STORAGE CAPACITY MANAGMENT TABLE
NOTIFY HOST/MANAGER OF ERROR INFORMATION VOLUME CREATION/ASSIGNMENT PROCESS
1008
1707
ISSUE COMPLETION NOTICE TO HOST/MANAGER
VOLUME CREATION/ASSIGNMENT PROCESS

FIG. 11

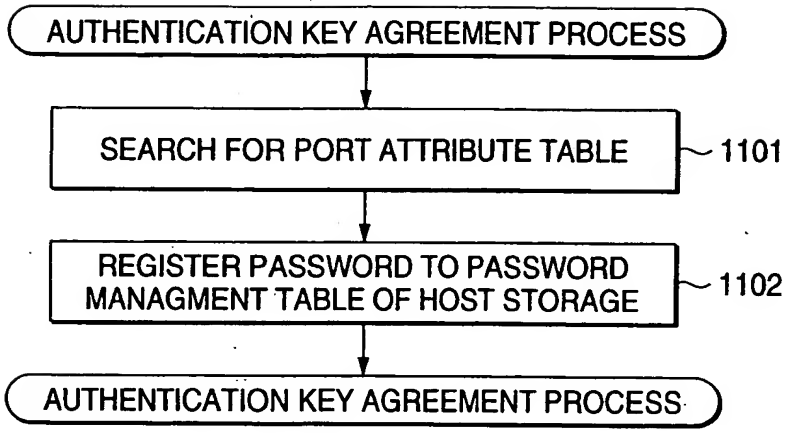

AUTHENTICATION KEY AGREEMENT PROCESS
SEARCH FOR PORT ATTRIBUTE TABLE
1101
REGISTER PASSWORD TO PASSWORD MANAGMENT TABLE OF HOST STORAGE
1102
AUTHENTICATION KEY AGREEMENT PROCESS

FIG. 12

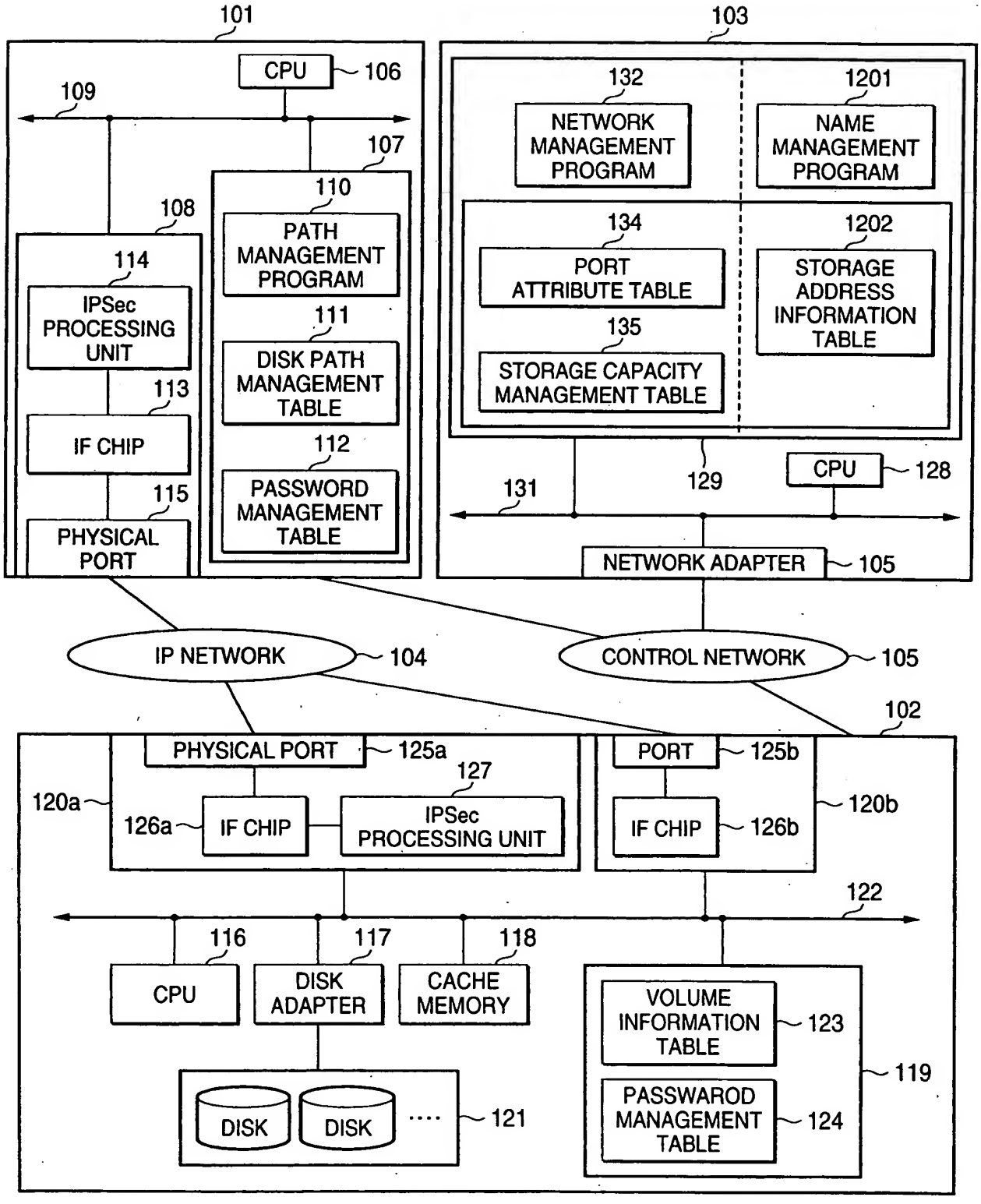

101
CPU
106
109
107
110
108
PATH MANAGEMENT PROGRAM
114
IPSec PROCESSING UNIT
111
DISK PATH MANAGEMENT TABLE
113
IF CHIP
112
PASSWORD MANAGEMENT TABLE
115
PHYSICAL PORT
103
132
NETWORK MANAGEMENT PROGRAM
1201
NAME MANAGEMENT PROGRAM
134
PORT ATTRIBUTE TABLE
1202
STORAGE ADDRESS INFORMATION TABLE
135
STORAGE CAPACITY MANAGEMENT TABLE
129
CPU
128
131
NETWORK ADAPTER
105
IP NETWORK
104
CONTROL NETWORK
105
102
PHYSICAL PORT
125a
127
120a
126a
IF CHIP
IPSec PROCESSING UNIT
PORT
125b
120b
IF CHIP
126b
122
116
117
118
CPU
DISK ADAPTER
CACHE MEMORY
VOLUME INFORMATION TABLE
123
119
PASSWAROD MANAGEMENT TABLE
124
DISK
DISK
....
121

FIG. 13

1301 OBJECT IDENTIFIER	1302 IP ADDRESS	1303 TCP PORT NUMBER	1304 OBJECT IDENTIFIER OF ACCESSIBLE HOST
iqn.2003-03.com.example: storage1	10.10.10.201	3260	iqn.2003-01.com.example: host1
			iqn.2003-02.com.example: host2
iqn.2003-04.com.example: storage1	10.10.10.202	3261	iqn.2003-01.com.example: host1
			iqn.2003-02.com.example: host2
iqn.2003-05.com.example: storage2	10.10.10.203	3261	iqn.2003-01.com.example: host1
iqn.2003-06.com.example: storage3	10.10.10.204	3260	iqn.2003-02.com.example: host2

FIG. 14

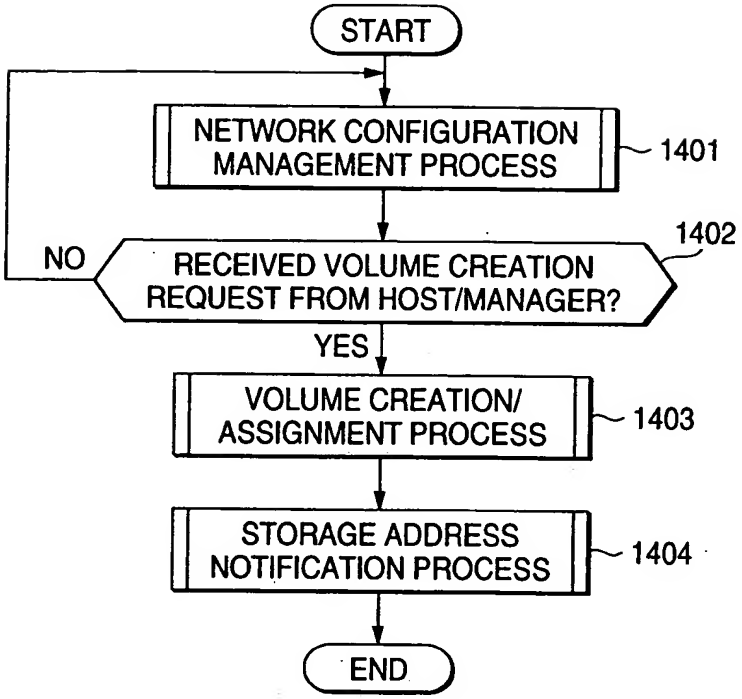

START
NETWORK CONFIGURATION MANAGEMENT PROCESS
1401
1402
NO
RECEIVED VOLUME CREATION REQUEST FROM HOST/MANAGER?
YES
VOLUME CREATION/ ASSIGNMENT PROCESS
1403
STORAGE ADDRESS NOTIFICATION PROCESS
1404
END

FIG. 15

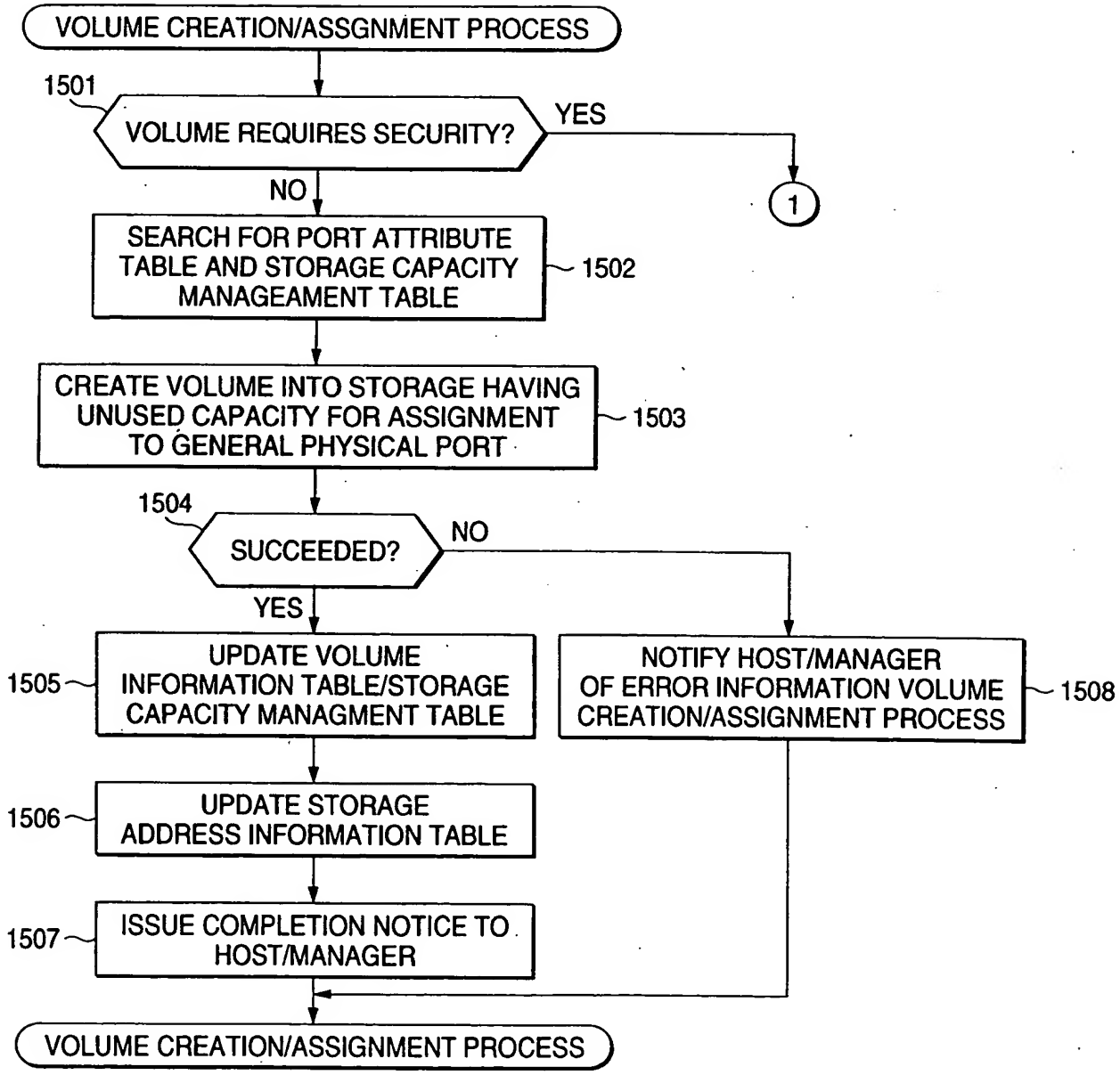

VOLUME CREATION/ASSGNMENT PROCESS
1501
VOLUME REQUIRES SECURITY?
YES
NO
1
SEARCH FOR PORT ATTRIBUTE TABLE AND STORAGE CAPACITY MANAGEAMENT TABLE
1502
CREATE VOLUME INTO STORAGE HAVING UNUSED CAPACITY FOR ASSIGNMENT TO GENERAL PHYSICAL PORT
1503
1504
SUCCEEDED?
NO
YES
1505
UPDATE VOLUME INFORMATION TABLE/STORAGE CAPACITY MANAGMENT TABLE
NOTIFY HOST/MANAGER OF ERROR INFORMATION VOLUME CREATION/ASSIGNMENT PROCESS
1508
1506
UPDATE STORAGE ADDRESS INFORMATION TABLE
1507
ISSUE COMPLETION NOTICE TO HOST/MANAGER
VOLUME CREATION/ASSIGNMENT PROCESS

FIG. 16

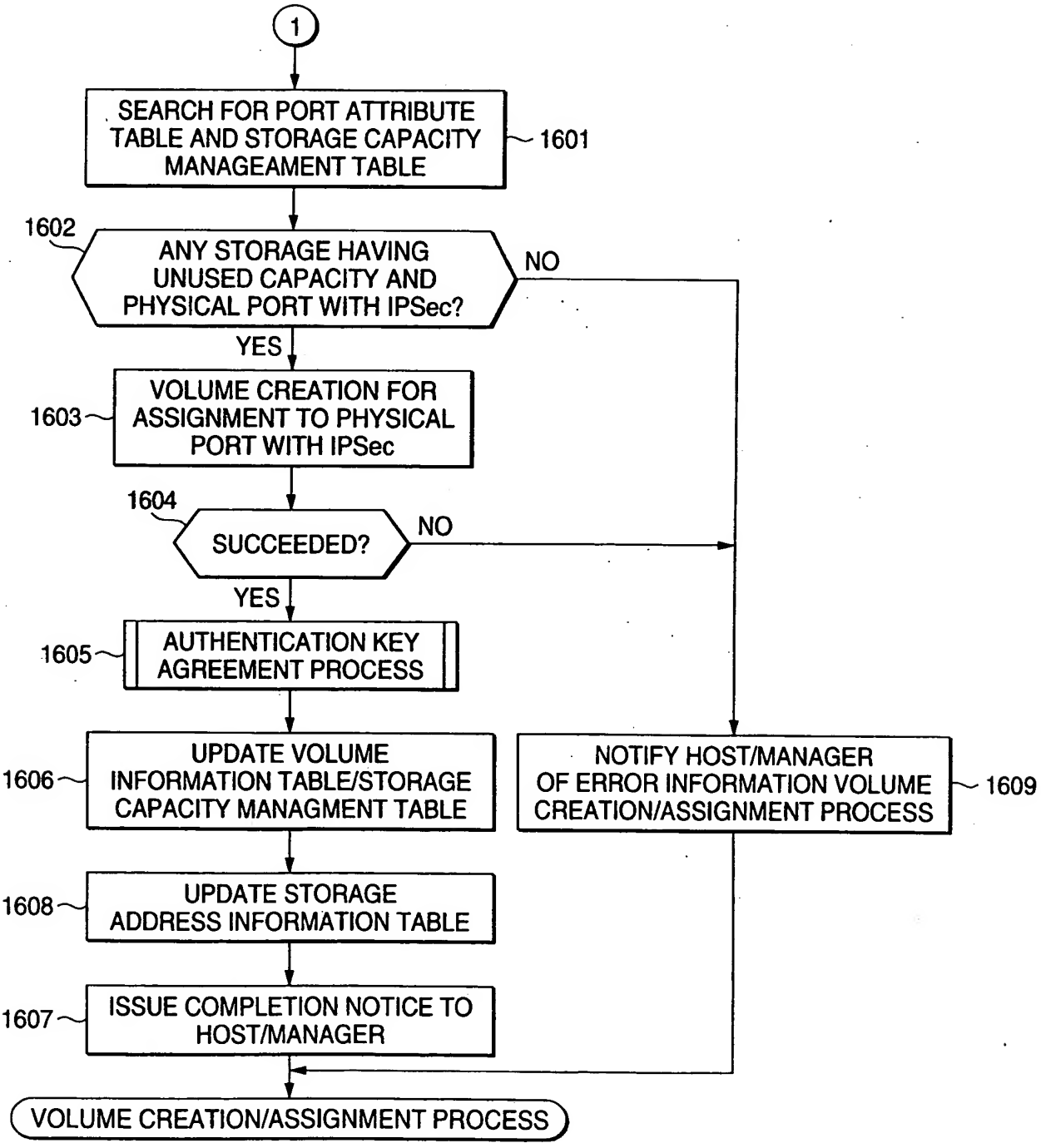

1
SEARCH FOR PORT ATTRIBUTE TABLE AND STORAGE CAPACITY MANAGEAMENT TABLE
1601
1602
ANY STORAGE HAVING UNUSED CAPACITY AND PHYSICAL PORT WITH IPSec?
NO
YES
1603
VOLUME CREATION FOR ASSIGNMENT TO PHYSICAL PORT WITH IPSec
1604
SUCCEEDED?
NO
YES
1605
AUTHENTICATION KEY AGREEMENT PROCESS
1606
UPDATE VOLUME INFORMATION TABLE/STORAGE CAPACITY MANAGMENT TABLE
NOTIFY HOST/MANAGER OF ERROR INFORMATION VOLUME CREATION/ASSIGNMENT PROCESS
1609
1608
UPDATE STORAGE ADDRESS INFORMATION TABLE
1607
ISSUE COMPLETION NOTICE TO HOST/MANAGER
VOLUME CREATION/ASSIGNMENT PROCESS

FIG. 17

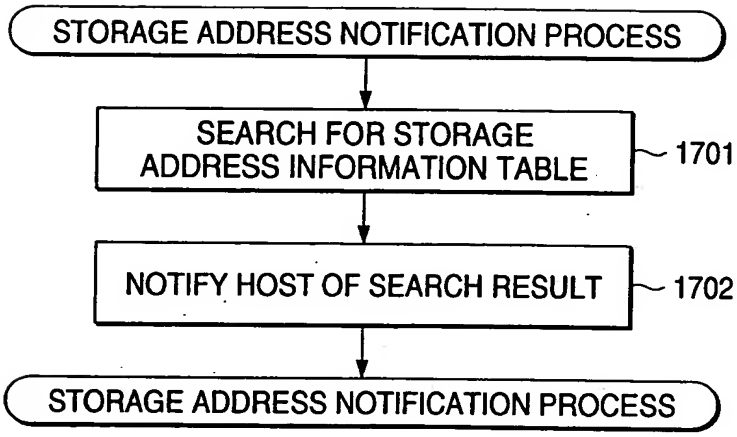

STORAGE ADDRESS NOTIFICATION PROCESS
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
1701
NOTIFY HOST OF SEARCH RESULT
1702
STORAGE ADDRESS NOTIFICATION PROCESS

FIG. 18

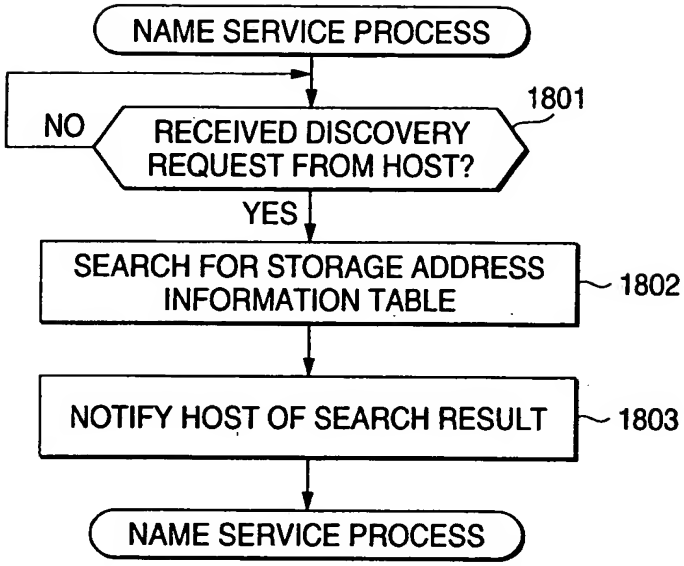

NAME SERVICE PROCESS
1801
NO
RECEIVED DISCOVERY REQUEST FROM HOST?
YES
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
1802
NOTIFY HOST OF SEARCH RESULT
1803
NAME SERVICE PROCESS

FIG. 19

1901 PHYSICAL VOLUME NUMBER	1902 LUN	1903 CAPACITY	1904 IP ADDRESS OF ASSIGNED PHYSICAL PORT	1905 TCP PORT NUMBER	1906 OBJECT IDENTIFIER OF ASSIGNED PHYSICAL PORT	1907 PROVIDED WITH IPSec?
VOL. 0	0	200GB	10.10.10.201	3260	iqn.2003-01.com.example: storage1	YES
			10.10.10.202	3260		NO
VOL. 1	1	350GB	10.10.10.201	3260		YES
			10.10.10.202	3260		NO
VOL. 2	2	600GB	10.10.10.203	3261	iqn.2003-02.com.example: storage1	NO
			10.10.10.204	3260		YES
VOL. 3	3	400GB	10.10.10.203	3261		NO
			10.10.10.204	3260		YES

FIG. 20

2001 OBJECT IDENTIFIER OF ASSIGNED PHYSICAL PORT	2002 IP ADDRESS OF ASSIGNED PHYSICAL PORT	2003 TCP PORT NUMBER	2004 PROVIDED WITH IPSec?	2005 OBJECT IDENTIFIER OF ACCESSIBLE HOST
iqn.2003-01.com.example: storage1	10.10.10.201	3260	NO	iqn.2003-01.com.example: host1
	10.10.10.202	3260	YES	iqn.2003-02.com.example: host2
iqn.2003-02.com.example: storage1	10.10.10.203	3261	NO	iqn.2003-01.com.example: host1
	10.10.10.204	3260	YES	iqn.2003-02.com.example: host2
iqn.2003-03.com.example: storage2	10.10.10.205	3261	YES	iqn.2003-01.com.example: host1

FIG. 21

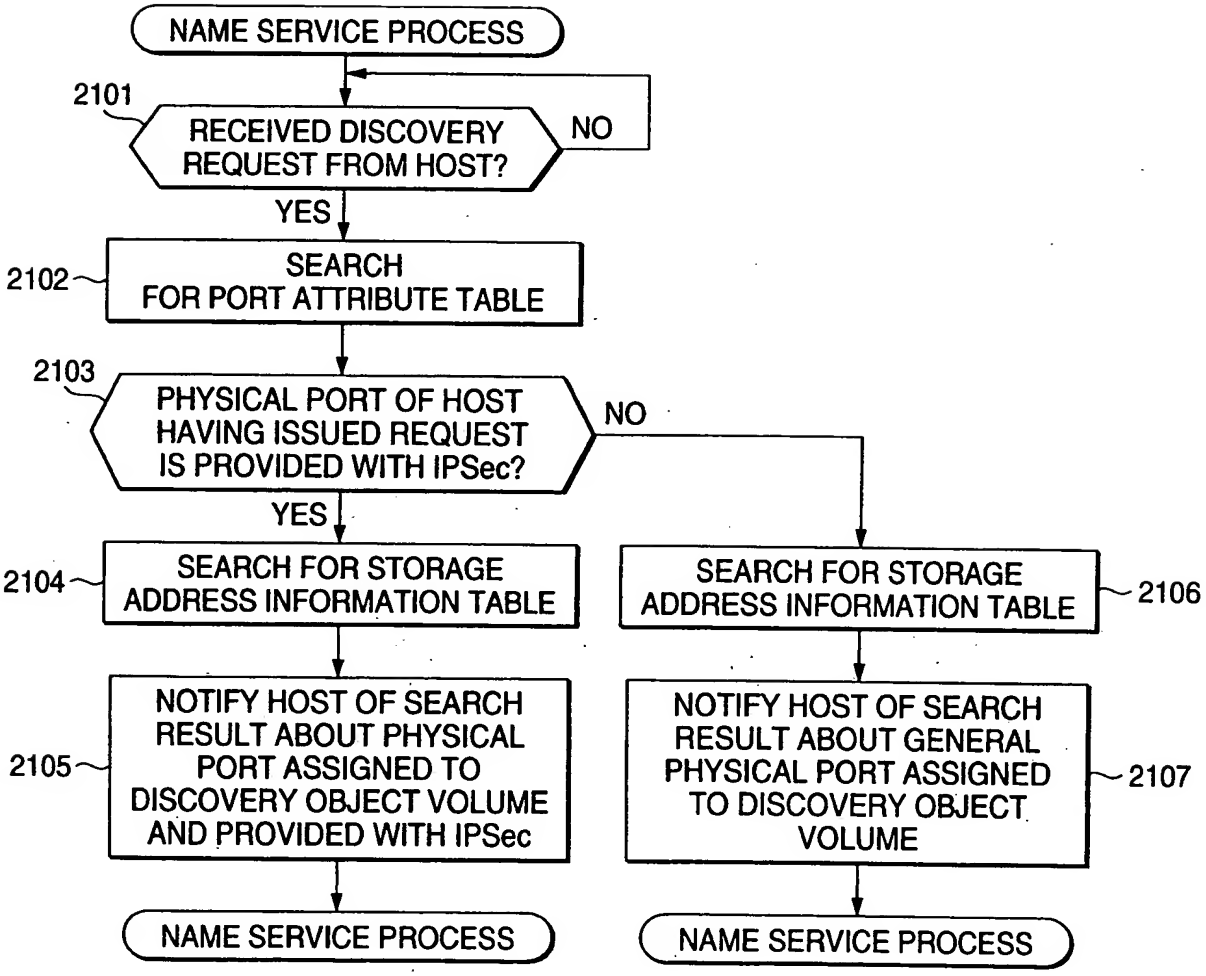

NAME SERVICE PROCESS
2101
RECEIVED DISCOVERY REQUEST FROM HOST?
NO
YES
2102
SEARCH FOR PORT ATTRIBUTE TABLE
2103
PHYSICAL PORT OF HOST HAVING ISSUED REQUEST IS PROVIDED WITH IPSec?
NO
YES
2104
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
2106
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
2105
NOTIFY HOST OF SEARCH RESULT ABOUT PHYSICAL PORT ASSIGNED TO DISCOVERY OBJECT VOLUME AND PROVIDED WITH IPSec
2107
NOTIFY HOST OF SEARCH RESULT ABOUT GENERAL PHYSICAL PORT ASSIGNED TO DISCOVERY OBJECT VOLUME
NAME SERVICE PROCESS
NAME SERVICE PROCESS

FIG. 22

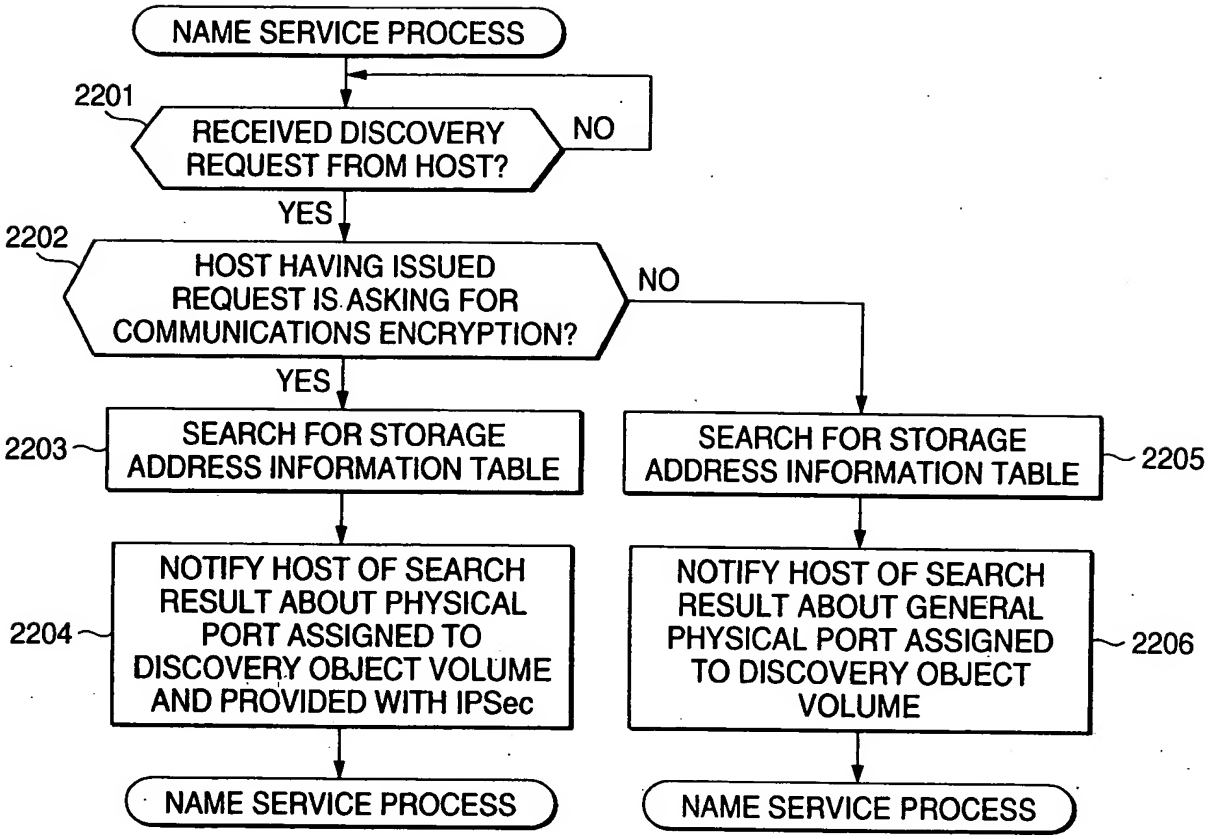
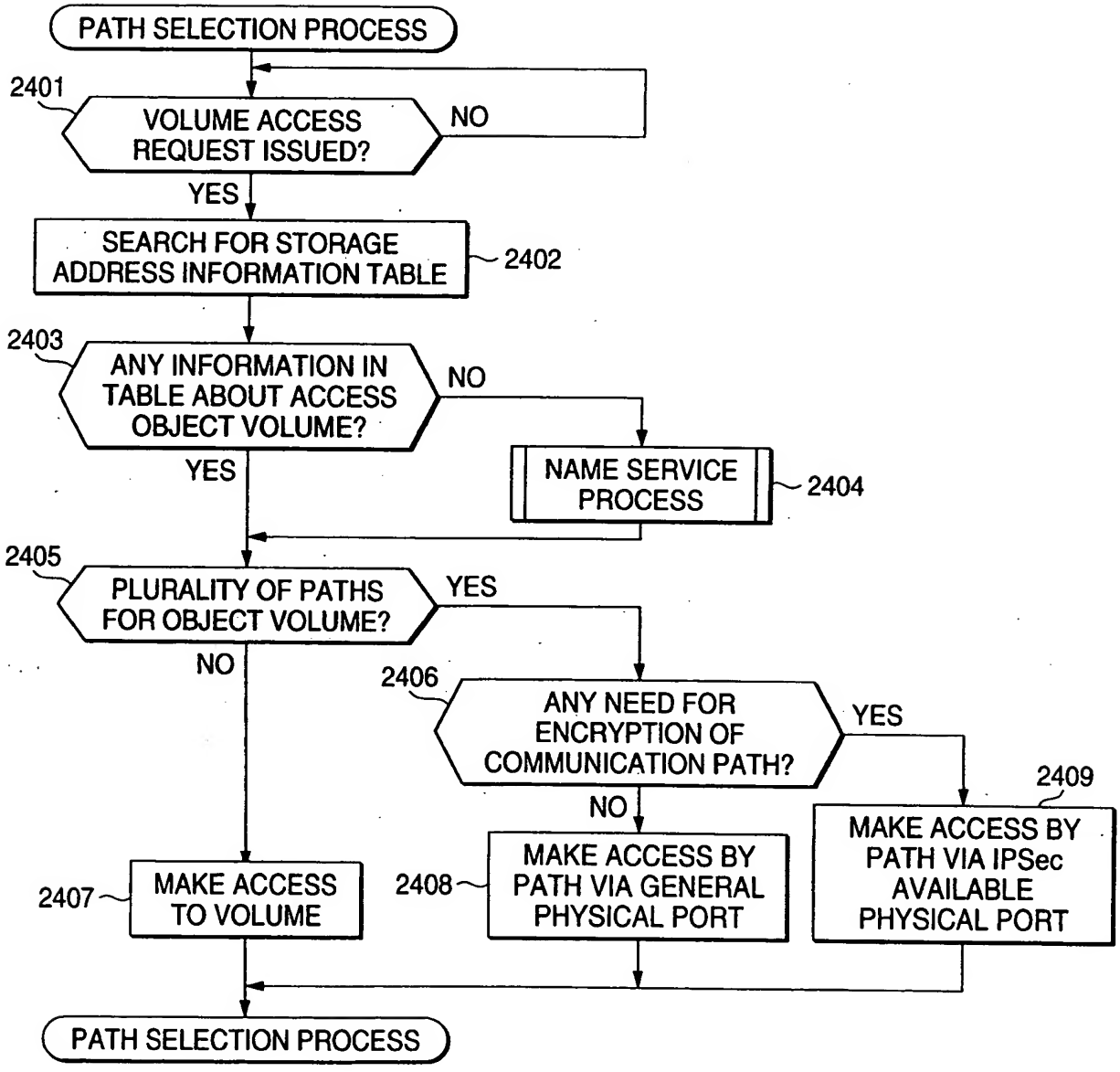

NAME SERVICE PROCESS
2201
RECEIVED DISCOVERY REQUEST FROM HOST?
NO
YES
2202
HOST HAVING ISSUED REQUEST IS ASKING FOR COMMUNICATIONS ENCRYPTION?
NO
YES
2203
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
2205
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
2204
NOTIFY HOST OF SEARCH RESULT ABOUT PHYSICAL PORT ASSIGNED TO DISCOVERY OBJECT VOLUME AND PROVIDED WITH IPSec
2206
NOTIFY HOST OF SEARCH RESULT ABOUT GENERAL PHYSICAL PORT ASSIGNED TO DISCOVERY OBJECT VOLUME
NAME SERVICE PROCESS
NAME SERVICE PROCESS

FIG. 23

2301 DEVICE NAME	2302 OBJECT IDENTIFIER	2303 LUN	2304 IP ADDRESS	2305 TCP PORT NUMBER	2306 PROVIDED WITH IPSec?
/dev/sda	iqn.2003-01.com.example: storage1	0	10.10.10.201	3260	NO
			10.10.10.202	3260	YES
/dev/sdb	iqn.2003-02.com.example: storage1	2	10.10.10.203	3261	NO
			10.10.10.204	3260	YES
/dev/sdc	iqn.2003-03.com.example: storage2	1	10.10.10.205	3261	YES

FIG. 24


PATH SELECTION PROCESS
2401
VOLUME ACCESS REQUEST ISSUED?
NO
YES
SEARCH FOR STORAGE ADDRESS INFORMATION TABLE
2402
2403
ANY INFORMATION IN TABLE ABOUT ACCESS OBJECT VOLUME?
NO
YES
NAME SERVICE PROCESS
2404
2405
PLURALITY OF PATHS FOR OBJECT VOLUME?
YES
NO
2406
ANY NEED FOR ENCRYPTION OF COMMUNICATION PATH?
YES
NO
2409
MAKE ACCESS BY PATH VIA IPSec AVAILABLE PHYSICAL PORT
2407
MAKE ACCESS TO VOLUME
2408
MAKE ACCESS BY PATH VIA GENERAL PHYSICAL PORT
PATH SELECTION PROCESS